
Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Primary Care Diabetes 14 (2020) 566–567

Contents lists available at ScienceDirect

Primary Care Diabetes

journal homepage: http://www.elsevier.com/locate/pcd

Letter to the Editor

## Obesity and risk of COVID-19: analysis of UK biobank

Whilst emerging evidence has suggested that those with cardiometabolic diseases are at higher risk of severe COVID-19 and resulting complications, less is known about the relative importance of related lifestyle factors. Obesity in particular is associated with impaired pulmonary function, a suppressed immune system and has been identified as a risk factor in previous infectious outbreaks [1]. Obesity also appears to be prevalent in subjects with COVID-19 [1,2]. However, as recently highlighted, there is a lack of information regarding the nature of association between body mass index (BMI) and COVID-19 [3].

In order to inform this area, we investigated the association between obesity and laboratory confirmed COVID-19 within UK Biobank (application number 36371). Our hypothesis was that BMI and waist circumference would be independently associated with COVID-19.

UK Biobank (https://www.ukbiobank.ac.uk/) is a large prospective cohort of 502,543 middle-aged adults. Assessments were conducted between March 2006 and July 2010. UK Biobank data are linked to national SARS-CoV-2 laboratory test data through Public Health England (PHE). Data provided included specimen origin (hospital inpatient indicating severe COVID-19 vs other settings). Data were available for the period 16th March 2020 to 3rd May 2020.

We undertook logistic regression progressively adjusted for potential confounders (Fig. 1). BMI was categorised as normal weight (18.5–<25 kg/m$^2$); overweight (25–<30 kg/m$^2$); obese (30–<35 kg/m$^2$); and severely obese (≥35 kg/m$^2$). Nonlinear effects were investigated using restricted cubic splines with knots placed at the 33th and 66th centile of variable distribution.

There were 2494 unique test results available, of which 882 (35.4%) were positive; 1408 (56.5%) tests were conducted on inpatients. Those with test data had a median (IQR) age of 71 (61, 76) years, BMI of 27·6 (24·7, 31·1) kg/m$^2$, waist circumference of 93 (83, 103) cm.

Both BMI and waist circumference (Fig. 1) were associated with testing positive for COVID-19 in a dose-response fashion. Adjustment for possible confounders did not change the results. The adjusted odds ratio for overweight, obese and severely obese subjects was 1·31 (95% CI: 1·05, 1·62), 1·55 (1·19, 2·02), and 1·57 (1·14, 2·17), respectively, compared to normal weight. Interpretation was not affected if data were restricted to in-patients (severe cases) only (data not shown).

Although limited by possible selection bias, these results provide early evidence for a dose-repose association between BMI, waist circumference and COVID-19. Further analysis on the association between obesity and COVID-19 complications, severity and mortality will be possible as UK Biobank data continues to be updated.

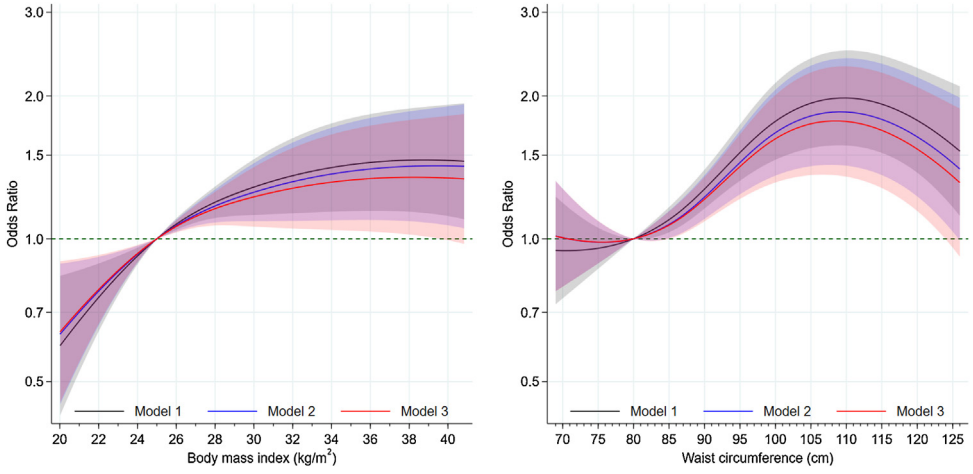


**Fig. 1.** Association between BMI, waist circumference and laboratory-confirmed SARS-CoV-2.
Model 1: unadjusted.
Model 2 adjusted for: age, sex, ethnicity, social deprivation [Townsend index], cancer illnesses [number], non-cancer illnesses [number], treatments/medications undertaken [number], systolic blood pressure and household density [number per house].
Model 3 adjusted for: Model 2 plus smoking status [never, past, current], walking pace [slow, steady average, brisk], leisure time physical activity [MET.minutes/week], fruit and vegetable consumption [portions per week], red meat consumption [portions per week] and alcohol intake [units/day].
References (odds ratio 1) are 25 kg/m$^2$ for BMI and 80 cm for waist circumference. Odds ratios (lines) and confidence intervals (areas) are plotted for ranges of BMI and waist circumference values (x axes) between the 2.5th and 97.5th centile of their distributions. Shaded area as 95% CI.

https://doi.org/10.1016/j.pcd.2020.05.011

## Funding/Support

This work was supported by the NIHR Leicester Biomedical Research Centre and NIHR Applied Research Centre East Midlands. Data was analysed using UK Biobank application number 36371

## Role of the Funder/Sponsor

The funder/sponsor had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

## Conflict of interest

We declare no competing interests.

## References

[1] G. Muscogiuri, G. Pugliese, L. Barrea, S. Savastano, A. Colao, Obesity: the "Achilles heel" for COVID-19? Metabolism-Clinical and Experimental (2020), Online first doi: https://doi.org/10.1016/j.metabol.2020.154251.

[2] S. Richardson, J.S. Hirsch, M. Narasimhan, J.M. Crawford, T. McGinn, K.W. Davidson, D.P. Barnaby, L.B. Becker, J.D. Chelico, S.L. Cohen, Cookingham J. Presenting Characteristics, Comorbidities, and outcomes among 5700 patients hospitalized with COVID-19 in the New York City Area, JAMA (2020), Online first doi: https://doi.org/10.1001/jama.2020.6775.

[3] S.W. Flint, A.A. Tahrani, COVID-19 and obesity—lack of clarity, guidance, and implications for care, Lancet Diabetes Endocrinol. (2020), http://dx.doi.org/10.1016/S2213-8587(20)30156-X.

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20 May 2020
Available online 28 May 2020